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New records of the invasive mollusk *Melanoides tuberculata* (Müller, 1774) (Gastropoda, Thiaridae) in the Brazilian Northeast

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Abstract

Melanoides tuberculata (Müller, 1774) was recorded during field surveys of the malacofauna of Território Vale do Guaribas in Piauí state, northeastern Brazil. Individuals were observed every month (June 2017–September 2018) in both lotic and lentic habitats. Considering that *M. tuberculata* has high reproductive and adaptative capacities besides being an intermediate host of digenetic trematodes, this invasive species is expected to be a threat to native biodiversity. Furthermore, it may become a serious environmental problem considering the multiple uses of the water bodies where it lives.

Keywords

Aquatic snail, bio invasion, invasive species, semiarid.

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Introduction

The freshwater snail *Melanoides tuberculata* (Müller, 1774), originally described to India, occurs throughout the intertropical belt of the Old World from Africa to Southeast Asia (Vaz et al. 1986, Facon et al. 2003, Vogler et al. 2012). This species has become widespread around the world, and molecular data support the hypothesis of multiple introduction events into countries of the New World (Facon et al. 2003). Currently, due to their high reproductive and invasive capacity, besides its medical and veterinary importance (Bolaji et al. 2011, Pinto and Melo 2011, Coelho et al. 2018), the occurrence of this species has been monitored around the world.

In Brazil, *M. tuberculata* was first recorded in the literature in 1986, but there are earlier, unpublished reports about the presence of individuals since 1967 in Santos on the São Paulo state coastline (Vaz et al. 1986). Since these early reports, there have been several records of its presence in new habitats in regions more distant from the probable initial dispersal point (see e.g. Fernandez et al. 2003, Santos et al. 2010, Agudo-Padrón 2011, Souto et al. 2011, Lima et al. 2013, Coelho et al. 2018).

The distribution of *M. tuberculata* in Brazil was recently updated, and, according to data from the literature and biological collections, this species occurs in

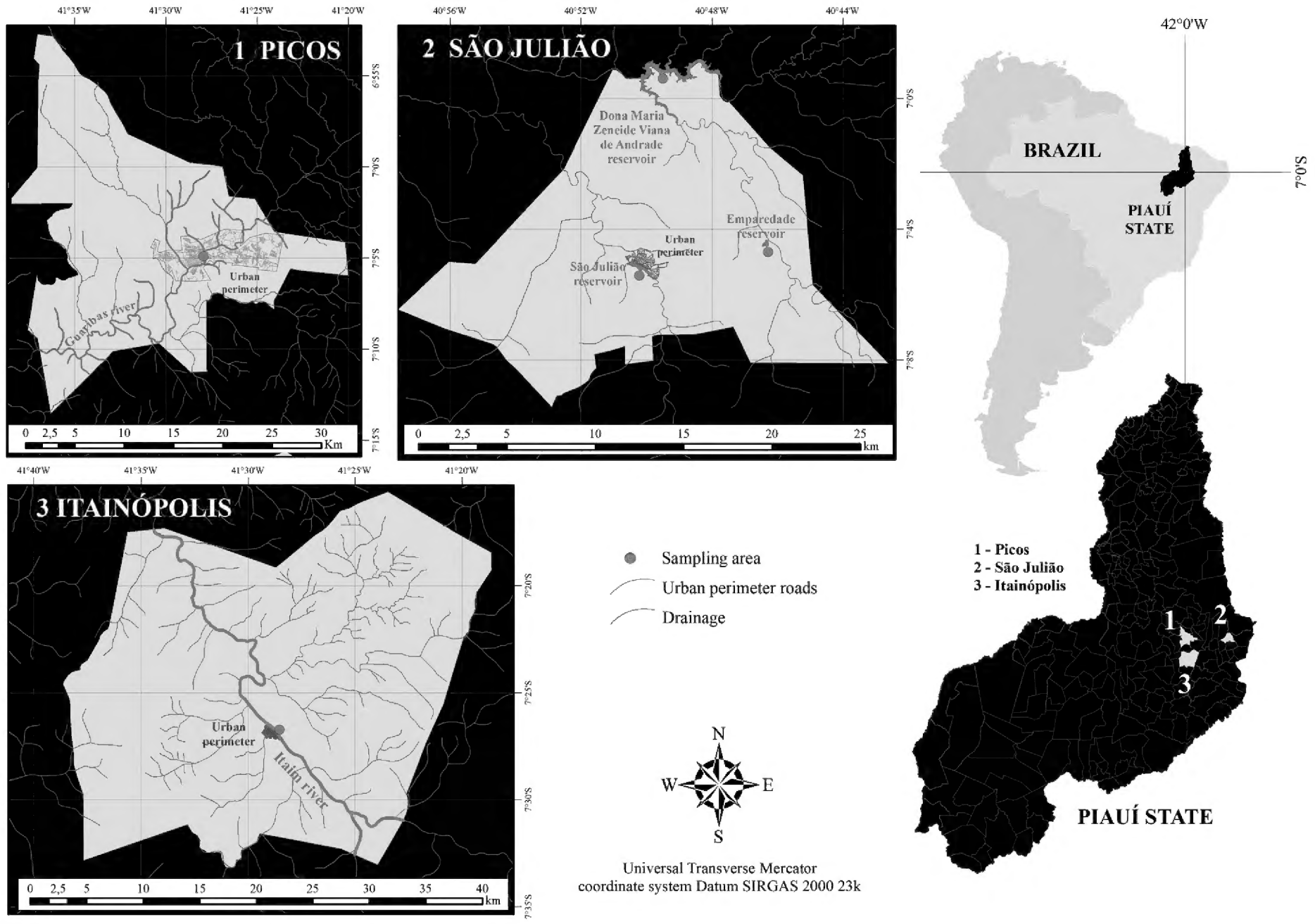

Figure 1. Sampling place of *Melanoides tuberculata* in water bodies of Território Vale do Guaribas, Piauí, Brazil.

20 Brazilian states and the Federal District and in 351 cities in total (Coelho et al. 2018). According to Coelho et al. (2018), most records are from states in the Northeast region, followed the Southeast, North, Midwest and South regions. Despite the number of records in the Northeast region, the distribution of *M. tuberculata* remains underestimated in Piauí state, but this is mainly due to the lack of surveys. There are only 2 records of it in Piauí: from Teresina city near the border with Maranhão state (Coelho et al. 2018) and from Parnaguá city in southwestern Piauí (Fernandez et al. 2003).

Melanoides tuberculata is a good example of how the combination of life history traits, genetic background, and human influence can contribute to the introduction and the establishment of a species in a novel environment (Vogler et al. 2012). Thus, it is imperative to acquire knowledge about the status of dispersion of this species in Brazilian waters. We present new records and report on the occurrence of *M. tuberculata* in the Território Vale do Guaribas, the most important region in northeastern Piauí state, in a semiarid region of Brazil.

Methods

The Território Vale do Guaribas comprises an area of slightly over 22,800 km^2 in northeastern Piauí state and has 23 cities (Superintendência de Planejamento Estratégico e Territorial do Piauí 2017). The low rainfall and high temperatures associated with a very conspicuous dry season cause water scarcity, the most important environmental characteristic that drives the dynamics of freshwater communities in this valley.

As part of a long-term survey project of the malacofauna of the Território Vale do Guaribas, collections were made monthly between June 2007 and September 2018 in lotic water bodies in the cities of Picos and Itainópolis and also in the lentic habitat of São Julião (Fig. 1). In Picos, individuals were obtained along an urban stretch of the Guaribas River. In Itainópolis, sampling was carried out in the urban perimeter of the Itaim River. In São Julião, sampling was made at the São Julião reservoir, which is located in the urban area, as well as the Dona Maria Zeneide Viana de Andrade (formerly Piaus) and Emparedade reservoirs, both located in rural areas. The sampling stations were chosen because they are perennial water bodies, important to the local human population, and accessible, and because mollusks are massively present at these places.

Five sampling stations were established in the rivers. Three stations in the reservoirs were established, all 1.5 m from the shore. Snails were collected using sieves of 21 cm in diameter, which were attached to a 1.5 m long wooden rod. Snails were stored in plastic containers along with a sample of the substrate and water. All materials were transported to the Laboratory of Ecology, Parasitology and Neglected Diseases (LAPEDONE) at

the Instituto Federal do Piauí. Sorting and identification of the individuals was carried out at the laboratory. The individuals were preserved in alcohol 98% and part was sent to Coleção de Moluscos do Instituto Oswaldo Cruz, Fundação Oswaldo Cruz, Rio de Janeiro, Brazil (CMIOC) to confirm the identification. The soft parts of voucher specimens were preserved in Railliet & Henry's solution (0.85% NaCl solution: 93 ml; formaldehyde: 5 ml; glacial acetic acid: 2 ml) and the shells were dried. All material is deposited in the CMIOC.

The field collections were authorized by Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio), through Sistema de Autorização e Informação em Biodiversidade (SISBIO) permit number 60423-5.

Results

***Melanoides tuberculata* (Müller, 1774)**

New records. Brazil: Piauí. Picos: Guaribas River (07° 05.19′S, 041°28.06′W), Santos, O. coll., July 2017–April 2018 (CMIOC 11612, 20 dry shells). Itainópolis: Itaim River (07°26.54′S, 041°28.35′W), Leal, M.F. coll., October 2017–September 2018 (CMIOC 11596, 38 dry shells). São Julião: São Julião reservoir (07°05.00′S, 040° 50.28′W), Rocha, A.J. coll., June 2017–April 2018 (CMIOC 11599, 18 dry shells). São Julião: Emparedade reservoir (07°04.27′S, 040°46.18′W), Rocha, A.J. coll., June 2017–April 2018 (CMIOC 11602, 12 dry shells; 4 animals in Railliet & Henry's solution). São Julião: Dona Maria Zeneide Viana de Andrade reservoir (06°59.25′S, 40°49.58'W), Rocha, A.J. coll., June 2017–April 2018 (CMIOC 11605, 21 dry shells).

Identification. *Melanoides tuberculata* was identified in field by its gregarious behavior, easily creating large population clusters. The shell is dark brown, dextral, moderately thick, elongately conical, and sculptured with spiral striae and small nodules at regular intervals. The aperture is oval and approximately 1/3 of the length of the shell, with the inner lip slightly thickened and the outer lip thin and simple (Fig. 2).

The shells of our specimens match the descriptions by Chagas et al. (2018), Quirós-Rodríguez (2018), Santos et al. (2012), Ohlweiler et al. (2010), and Simone (2006).

Discussion

The dispersion of *M. tuberculata* in the Território Vale do Guaribas might have been facilitated by anthropic actions, associated with trade in aquaculture products as observed in other states (Santos et al. 2012). The explanation for this means of dispersion is reinforced due to the absence of connection between the water bodies studied here. Besides that, there is no connection between the studied environments and those closer with previous records of *M. tuberculata* as the cities Parnaguá, Teresina (Piauí) and Orocó (Pernambuco), with 492, 260 and 270 km away from the Territory respectively.

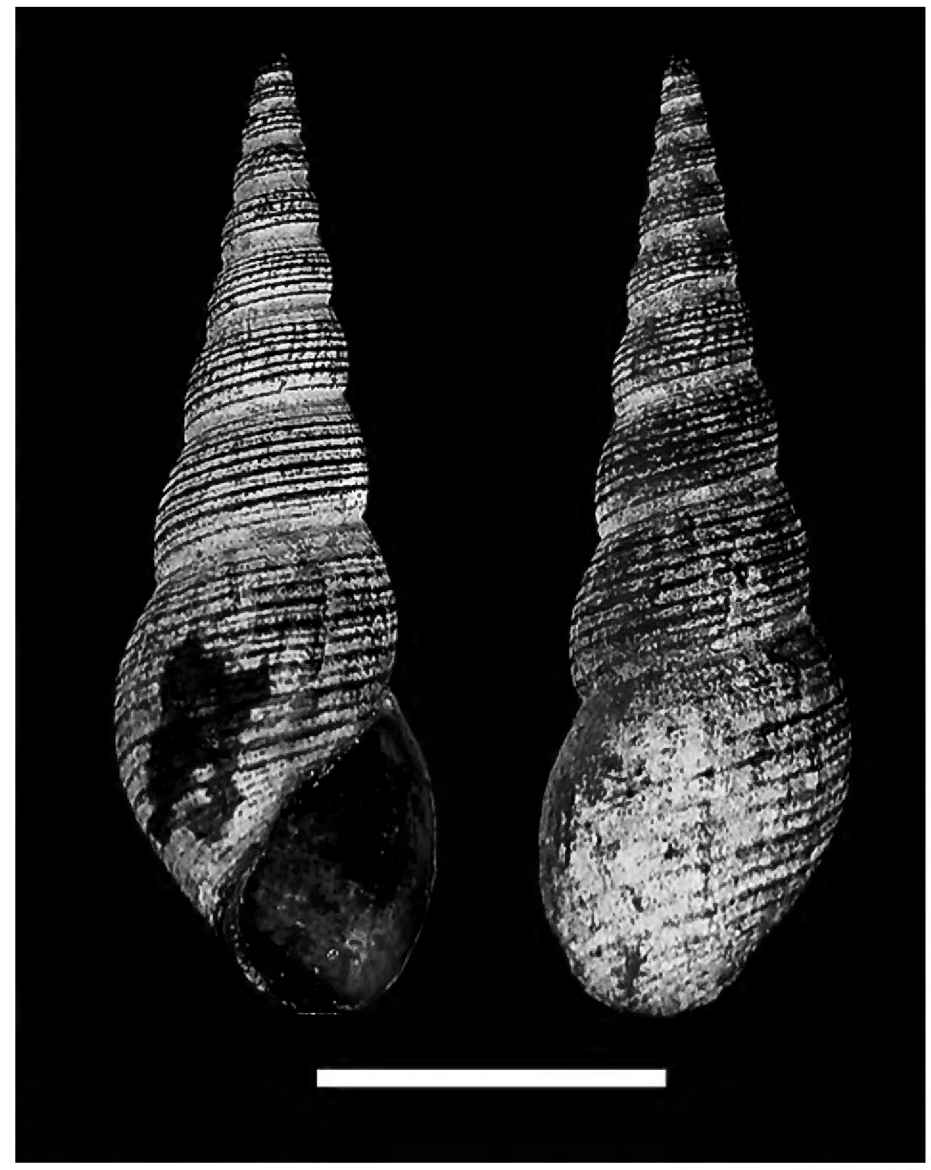

Figure 2. *Melanoides tuberculata* from water bodies of Território Vale do Guaribas, Piauí, Brazil (voucher number LBIFPI 01). Scale bar = 10mm.

Melanoides tuberculata is a quite interesting species because it reproduces parthenogenetically (Jacob 1957). Besides that, it tolerates a variety of environmental stressors (Weir and Salice 2011) and is extremely resistant to salinity variation (Farani et al. 2015, Silva and Barros 2015, Bolaji et al. 2011), desiccation (Facon et al. 2004), and temperature (Pointier 1993).

This set of biological features allow for *M. tuberculata* to out-compete with other species in newly invaded places mainly due to its capacity to suppress populations of native species. Its presence in reservoirs in semiarid Brazil is said to be responsible for the low diversity of native mollusks in these areas (Almeida et al. 2018). Fernandez et al. (2001) reported on the decline of a population of *Pomacea lineata* (Spix, 1827) due to the presence of *M. tuberculata*. Fernandez et al. (2003) also reported the total replacement of a natural population of *Aylacostoma tenuilabris* (Reeve, 1860) (Thiaridae) after the introduction of *M. tuberculata*.

Despite the potential for *M. tuberculata* to be a threat to native species, the effect of *M. tuberculata* on the malacofauna of the Território Vale do Guaribas remains unknown. Perennial water bodies in a semiarid region, such as the ones we studied, are rare. Despite the constant low volume of water, these water bodies are extensively used by the human population for multiple purposes such as consumption, irrigation, fishing, and recreation. Thus, it is of extreme importance to know the long-term evaluation impact of *M. tuberculata* in the Território Vale do Guaribas.

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Authors' Contributions

ELS analyzed the data and wrote the manuscript. MFL collected specimens from the Itaim River. OS collected specimens from the Guaribas River. AJR collected specimens from the reservoirs. ACLP revised the English version of the manuscript. TGP coordinated the research and revised the manuscript. All authors corrected, revised, and discussed the data.

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